

U.S. Patent Application Serial No. 09/884,998
Amendment filed December 27, 2006
Reply to OA dated September 27, 2006

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1 - 24 (Canceled)

Claim 25 (Currently Amended): A crawler belt bushing, comprising:

a steel having a carbon content equal to those of medium carbon steels and/or eutectoid steels, which is 0.35 wt% or more;

quench hardened layers formed so as to extend toward its ~~wall~~ core region from its outer circumferential surface and from its inner circumferential surface respectively; ~~and~~

a soft layer formed in the core region between said quench hardened layers; and

intermediate layers formed between said soft layer and each said quench hardened layer;

said quench hardened layers and said soft layer being formed by: (a) increasing the cooling rate of the outer circumferential surface in order to reduce heat capacity at the core and by second cooling of the workpiece from its outer circumferential surface which is started a certain time after

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the first cooling and/or (b) increasing the cooling rate of the outer circumferential surface by first cooling of the workpiece from its inner circumferential surface in order to partially make the core unhardenable by utilizing the mass effect of the wall of the workpiece and by second cooling of the workpiece from its outer circumferential surface which is started a certain time after the first cooling, wherein the quench hardened layer of the outer circumferential surface has a depth greater than the depth of the quench hardened layer of the inner circumferential surface,

~~said core region having said soft layer, said soft layer being attached to and between
said inner and outer circumferential surfaces and~~

said soft layer being composed of a structure including pearlite and banite, which are precipitated during cooling from the quenching temperature,

said bushing being low temperature tempered.

Claim 26 (Original): A crawler belt bushing according to claim 25, wherein the hardened depth of the outer circumferential surface is not less than 1.1 times the hardened depth of the inner circumferential surface.

Claim 27 (Previously Presented): A crawler belt bushing according to claim 25 or 26, wherein said steel has an alloy content within the range of DI values with which the bushing is through hardened by simultaneous cooling of the inner and outer circumferential surfaces and with which the hardened depth obtained by cooling from the inner circumferential surface only is about one half the thickness of the bushing.

Claim 28 (Previously Presented): A crawler belt bushing according to claim 25, which is tempered at high temperature such that the quench hardened layer of the inner circumferential surface has lower hardness than the quench hardened layer of the outer circumferential surface and wherein the surface hardness of the quench hardened layer of the inner circumferential surface is adjusted to Vickers hardness Hv 450 to 650.

Claim 29 (Original): A crawler belt bushing according to claim 25, which is through hardened at its upper and lower ends.

Claim 30 (Currently Amended): A crawler belt bushing, comprising a carbon 0.35 to 2.0 wt%, containing at least one of the alloying elements of Mn, Si, Cr, Mo and Ni, and made by a method in which

a bushing workpiece made of steel, which is through hardened by simultaneous cooling from the outer and inner circumferential surfaces of the workpiece, is induction heated from the outer circumferential surfaces of the workpiece, so as to raise at least the surface temperature of the inner circumferential surface to a quenching temperature, and thereafter, a series of quenching operations including:

firstly cooling the workpiece from the inner circumferential surface;

1: heating the workpiece from the outer circumferential surface while cooling the workpiece from the inner circumferential surface; and

2: then, cooling the workpiece from the outer circumferential surface,

wherein said crawler belt bushing comprises

quench hardened layers formed ~~therefrom extend~~ extending toward the ~~wall~~ core region of the workpiece from the outer circumferential surface and from the inner circumferential surface respectively ~~and form,~~

a soft layer in the core region between said quench hardened layers,

and intermediate layers formed between said soft layer and each said quench hardened layer,

~~said core region having a soft layer, said soft layer being attached to and between said inner and outer circumferential surfaces, and~~

said soft layer being composed of a structure including pearlite and bainite, which are

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precipitated during cooling from the quenching temperature and which contain or do not contain granular cementite dispersed therein.

Claim 31 (Original): A crawler belt bushing according to claim 30, wherein the hardened depth of the outer circumferential surface is not less than 1.1 times the hardened depth of the inner circumferential surface.

Claim 32 (Original): A crawler belt bushing according to claim 30, which is tempered at 140 to 350°C after quenching.

Claim 33 (Original): A crawler belt bushing according to claim 30, which is through hardened at its upper and lower ends.